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RIPARIAN FORESTS OF THE SACRAMENTO VALLEY, CALIFORNIA[1]

KENNETH THOMPSON
University of California, Davis

MODERN observers of the Sacramento Valley are struck, even dismayed, by the paucity of trees. Typically, trees are few in the open country, and appear even then only in orchards, eucalyptus plantings, occasional shelter-belts or field-side rows, around house sites, and in meager discontinuous strips along some of the watercourses. This dearth, particularly of large trees, imparts a distinctive character to the landscape and has varied consequences, not all of which are aesthetic. Unpleasant, desiccating north winds sweep virtually unobstructed over the monotonous, treeless valley floor. Livestock and humans lack shade from the powerful summer sun, and local sources of wood are scarce. But partly offsetting these and other disadvantages are, of course, some items on the credit side of the ledger, now mainly of historic importance. Pioneer settlers, for example, did not have to labor unproductively to clear wooded land for agricultural and other uses, and travel was relatively easy during much of the year.

Even so, pioneers found the region much more wooded than it is today.[2] The pristine[3] vegetation of the valley floor consisted of three major plant associations. Most extensive was the prairie, a grassland community interspersed in places with scattered valley oaks (*Quercus lobata*). The lower portions of the flood plain supported a marshgrass community, and bordering the larger streams, mainly on natural levees, were strips of woodland, sometimes several miles wide, hereinafter termed riparian forests.[4]

With the coming of the white man the pristine vegetation was modified with a rapidity and completeness matched in few parts of the United States. The change was initiated in the late Spanish and Mexican phases, and accelerated by the Anglo-American occupance.[5] The native bunchgrasses of the Sacramento Valley have been grazed out or plowed and planted to crops, and alien grasses and herbaceous plants have been introduced and widely established. The oaks that once dotted sections of the grassland have mostly disappeared, either cut down or killed at different times and places by too high water tables and saline accumulations resulting from irrigation, or lowered water tables

[1] This study was supported by a grant from the Committee on Research of the University of California, Davis. The author gratefully acknowledges helpful suggestions from Dr. Jack Major, Department of Botany, University of California, Davis.

[2] Local exceptions to this statement may be noted. There are, for instance, many artificially planted trees in the Sacramento Valley. Beside shade and ornamental trees there are almonds, apricots, citrus, English walnuts, olives, peaches, plums, prunes, and others. However, the cultivation of many of these tree crops is strongly localized, e.g., apricots around Winters, olives around Corning, peaches around Marysville, so that these plantings are only locally prominent features of the landscape.

[3] The term "pristine vegetation" is used hereinafter to designate the conditions existing at the arrival of the white man.

[4] There appears to be no accepted, and acceptable, term with which to label these forests. In geographical literature the term "gallery or *galleria* forests" is sometimes applied to the woody vegetation that prevails on stream banks in savanna and grassland country. However, the term is vaguely used and has misleading connotations. Furthermore, it lacks an established place in ecological writing. For instance, J. Richard Carpenter's *An Ecological Glossary* (New York: Hafner, reprint 1956) contains no definition of gallery forests. The term "levee forest" was considered by the author and, while appropriate for most of the wooded area under consideration, was rejected in favor of the less restrictive "riparian forest," which is here used to apply to all stream-side forest and woodland. Botanical nomenclature follows Philip A. Munz and David D. Keck, *A California Flora* (Berkeley: University of California Press, 1959), except in historical quotations.

[5] The Anglo-American period in California dates officially from the signing of the Treaty of Guadelupe Hidalgo on February 2, 1848, whereby the former Spanish colonial outpost on the Pacific passed from Mexican to United States control. However, the Spanish can hardly be said to have occupied the Sacramento Valley; they did little more than claim its sovereignty. Occupation of the area by non-Indian peoples dates from the latter part of the Mexican period (1821–48) but was largely conducted by Americans and Europeans rather than genuine Mexicans. John Augustus Sutter, the pioneer settler of the Sacramento Valley who established a large agricultural colony near the site of the city of Sacramento, was a Swiss by birth and an American by adoption—although for reasons of expediency he became a Mexican citizen in 1841. The peopling of the Sacramento Valley by Anglo-American immigrants was, of course, irrevocably confirmed with the Gold Rush of 1849.

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caused by flood-control measures on headstreams and local pumping. Drainage and flood control have virtually eliminated marsh vegetation from the valley. And the major continuously wooded section of the Sacramento Valley, the riparian forests of the natural levees, has been cleared with only traces remaining. Indeed, clearing of the riparian forests was one of the first of a series of actions that drastically modified the landscape during the Anglo-American period. In the author's view, the significance of the extensive riparian forests, has been very largely overlooked by students of the Sacramento Valley. Jepson, in his *Manual of the Flowering Plants of California*, speaks of the "narrow curtain of trees along the streams ... composed of *Platanus racemosa*, *Populus fremontii*, *Salix nigra* var. *vallicola*, *laevigata*, and *lasiandra* ..." but ignores their former extent, although he discusses the historical development of other life-zones.[6] Munz and Keck, in their monumental *A California Flora*, virtually ignore riparian forests and make no reference to them in their synopsis of 29 California plant communities.[7] Burcham's *California Range Land* is exceptional in noting the occurrence of extensive woodland on the Sacramento Valley floor, but his pristine vegetation map is seriously in error as far as the valley is concerned.[8]

THE SACRAMENTO RIVER AND VALLEY

The Sacramento River has its source on the slopes of Mount Eddy, in the Trinity Mountains section of the Klamath Mountains, about 6,600 feet above sea level. In its upper reaches, the river flows swiftly in a steep, narrow valley through the rugged mountains. In this section the gradient is steep, falling 5,913 feet in the first 56 miles. Then, joined by the Pit River (its principal upper tributary), the Sacramento falls 447 feet in the 67 miles to Red Bluff. Below Red Bluff the valley opens out, and nearly level lowlands border the now gently flowing river for the rest of its course. In the remaining 247 miles of its course, below Red Bluff, the river falls only 240 feet, averaging less than one foot per mile (Fig. 1).

The term Sacramento Valley may, of course, be applied in the geomorphic sense to the inclined depression bordering the entire length of the river. Local custom, however, restricts the term to the extensive lowlands bordering the river below the vicinity of Red Bluff. This lowland extends about 150 miles north-south and spreads about 45 miles east-west at its widest point, averaging about 30 miles wide. The area of the Sacramento Valley, so defined, is about 5,000 square miles; the area of the entire Sacramento River drainage basin is 26,150 square miles.[9]

The boundaries of the Sacramento Valley (in this restricted sense) are delineated fairly sharply by the Coast Ranges on the west, the Klamath Mountains on the north, and the southern Cascade Range and northern Sierra Nevada on the east. The southern margins of the valley, in contrast, are indistinct because the extremely low terrain, cut by numerous branching channels of the river, merges imperceptibly with similar terrain at the lower end of the San Joaquin River Valley. This whole low-lying and level area is formed by the combined delta (so-called, but actually a marsh-filled structural basin) of the two rivers.

The Sacramento Valley consists essentially of a level, almost featureless lowland formed by the long-continued accumulation of sediments in a great structural trough lying between the Coast Ranges and the Cascades-Sierra Nevada.[10] For a long time the trough has been

[6] Willis Linn Jepson, *A Manual of the Flowering Plants of California* (Berkeley: Associated Students Store, 1923–25), p. 6.

[7] Munz and Keck, *op. cit.*

[8] L. T. Burcham, *California Range Land* (Sacramento: Department of Natural Resources, Division of Forestry, 1957). Burcham maps a strip of marshgrass bordering the Sacramento River as far north as Glenn County, an area roughly corresponding to the natural levees. This is a topographical impossibility. The marshgrass area was actually two separate discontinuous strips some distance from the river, often several miles, in the flood basins on both sides, and in the delta. Burcham also errs in showing the "oak woodland" of the valley as forming two strips, approximately enclosing the above-mentioned marshgrass, while actually the marshgrass more or less enclosed the "oak woodland." He appears to have these two plant associations reversed.

[9] *Sacramento River Basin*, Bulletin No. 26 (Sacramento: Division of Water Resources, 1931), p. 27.

[10] The ensuing section on valley topography is based mainly on Kirk Bryan, *Geology and Ground-Water Resources of the Sacramento Valley, California*, Water-Supply Paper 495 (Washington, D.C.: Department of the Interior, 1923), and F. H. Olmstead and G. H. Davis, *Geologic Features and Ground-Water Storage Capacity of the Sacramento Valley, California* (Open-file report approved for publication as a water-supply paper, Washington, D.C.: Department of the Interior, in press).

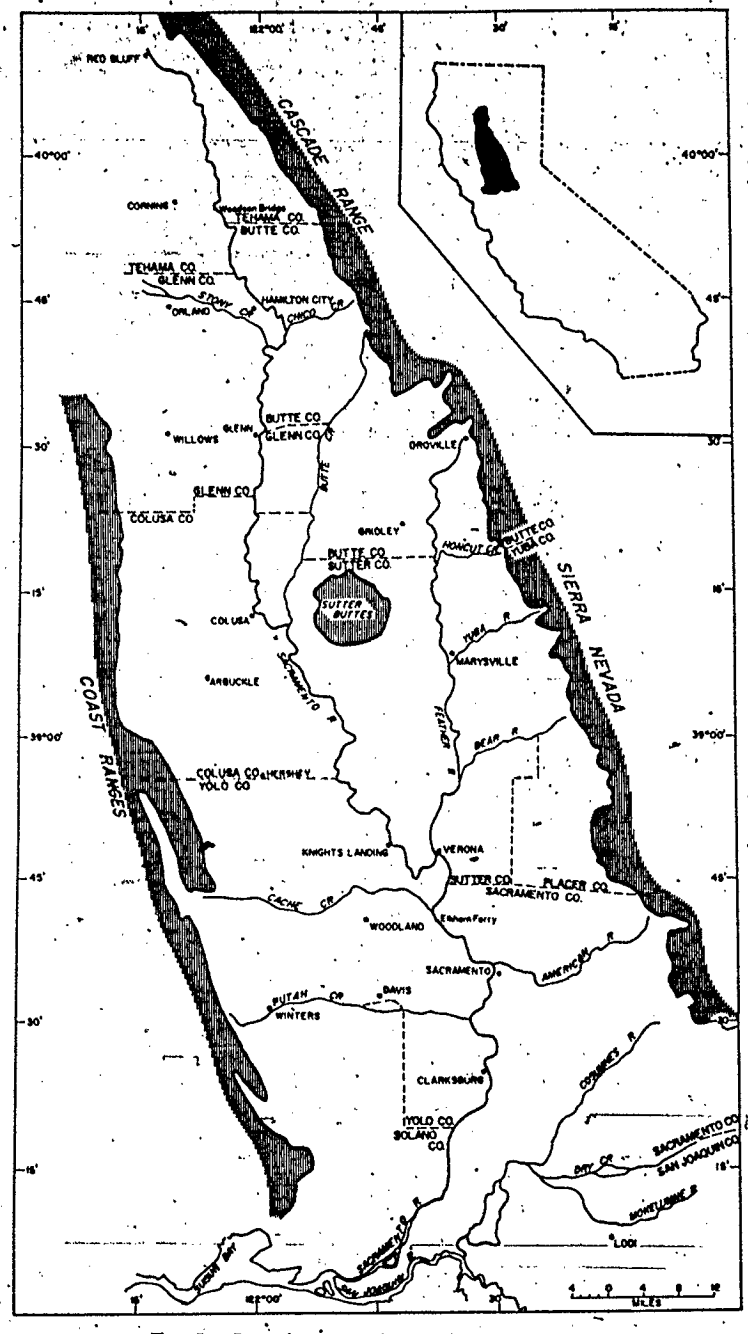

FIG. 1. Location map of the Sacramento Valley.

sinking and the enclosing mountain rising. Uplift of the mountains ha their erosion and provided much s the filling of the valley. Further sul lowered the valley, reduced strea and encouraged alluviation. Thus the river system has been, in som respects, essentially depositional erosional. A huge amount of fine r been deeply spread over the valley Sacramento and its major tributa the flat and monotonous surface.

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sinking and the enclosing mountains have been rising. Uplift of the mountains has promoted their erosion and provided much sediment for the filling of the valley. Further subsidence has lowered the valley, reduced stream gradients and encouraged alluviation. Thus the work of the river system has been, in some important respects, essentially depositional rather than erosional. A huge amount of fine material has been deeply spread over the valley floors of the Sacramento and its major tributaries—hence the flat and monotonous surface.

Although most of the surface of the Sacramento Valley is both low and level, some portions have been slightly elevated by faulting and folding, permitting stream erosion to produce slightly rolling topography. Largely from genetic considerations, Bryan recognized five natural divisions of the Sacramento Valley (Fig. 2): (1) "red lands" (above the present flood plain), (2) "river lands," (3) "flood basins," (4) "low plains," and (5) "islands."

The red lands (so-called because of iron-stained soils) consist of rolling country along both sides of the outer margins of Sacramento Valley. Formed from sediments deposited by upland tributary streams, they were originally smoothly and gently graded outward from the enclosing uplands. Uplift and faulting, however, encouraged dissection and imparted the present rolling terrain.

The low plains generally lie within, and at lower elevations than, the red lands, and have a nearly level surface, gently graded at an average rate of 5 to 10 feet per mile down to the valley floor. They have been formed of alluvium redeposited by the tributary streams engaged in dissecting the red lands. Although the low plains are characterized by extremely level alluvial surfaces, they include some irregularly deposited alluvium. Typically this is located where intermittent streams debouch from the mountains.

Another form of irregular alluviation, more or less intermediate between that of alluvial fans and true natural levees, has built up slightly elevated alluvial deposits along the lower reaches of some tributaries as they cross the low plains. These, termed channel ridges by Bryan, consist of elongated mounds that rise 10 to 25 feet above the neighboring low plains and range in width from 500 yards to 3 miles. They have been formed where tributary streams deposited part of their loads in crossing the low plains. It should be noted that the tributaries that gave rise to these irregular features, like the master streams, are now more or less subject to various flood controls and are thus no longer actively building these minor alluvial landforms.

Genetically related to the formation of channel ridges, but on a much larger scale, is the tendency of the Sacramento River and lower Feather River, like that of many other aggrading streams, to form natural levees. The greater elevation of the riparian strips can usually be seen in the field, and is quite noticeable on topographic maps with a contour interval of 5 feet. These natural levees are termed river lands by Bryan. In addition to their elevation, natural levees are differentiated from other flood plain features by the type of sediments from which they are formed. Since natural levees are built of sediments laid down by relatively fast-moving water they contain coarse-textured material. Elsewhere on the flood plain, sediments are usually deposited in slower-moving water and are thus finer-textured.

The natural levees are of relatively recent origin, and Bryan was able to state, from observations in 1912–14, that they (like the low plains) were still in process of formation. Before man's interference, the natural levees of the Sacramento rose from 5 to 20 feet above the flood basins. They range in over-all width from about 1 to 10 miles, averaging 3 miles. They are, of course, still in position, but are now generally surmounted by large artificial levees built for flood control. The enlargement and extension of artificial levees, and other flood control measures, have arrested, except very locally, the processes that formed the natural levees. Like the channel ridges, the natural levees formed corridors of generally dry land during times of flooding.

Enclosed between the natural levees and low plains is a series of very low saucer-like depressions which Bryan (following local usage) called flood basins. These are the lowest, and most nearly level, portions of the valley, and form complete, if shallow, basins without outlets. The largest of these basins are the Butte, Sutter, and American basins, on the east side of

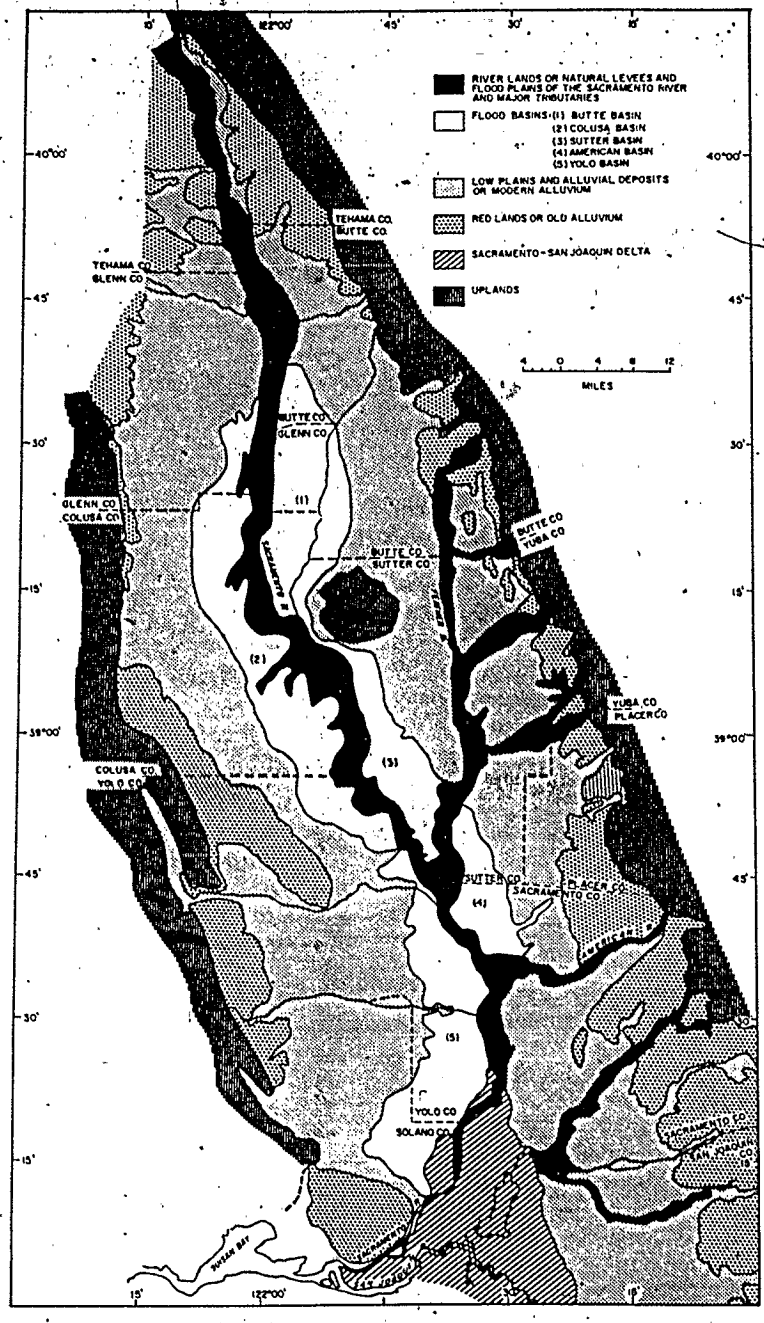

FIG. 2. Physiographic regions of the Sacramento Valley.

the Sacramento River, and the basins, on the west side.[11]

"The relatively high natura less effectively confined the their regular channels when at low or moderate stages. V spring runoffs were high, ho portions of the valley were level of the main streams. Acc of high water the lower port plain, i. e., the flood basins an plains, were converted into hu porary lakes. Because of the ness and shape, such floodwat escape but persisted for much ing a luxuriant growth of tul *tus*) and other marsh plants. seasonal variation of runoff i River system, the extent of t flood basins and adjacent area subject to considerable annual

Before reclamation of the ley, the flood basins and lo ceived flood water from sourc main streams. Important amo upland runoff that, because o posed by the natural levees, the main streams. In time of h poured off the low plains in w low parts of the valley. Becau of the flood basins and the le upland runoff did not reach th spreading out from the flood large sections of the Sacramen not all tributary streams cou with the Sacramento, they drai floor through a welter of distr themselves "in the intricate p which meander through the t ing the main river.[12] Few of the taries, which are mainly perer through direct channels with River. The Feather River, for i ample of a Yazoo type stream words, "only the large tributari the Sacramento by a definite ch

[11] In times past, the flood basin known as "tules" or "tulares," becaus tule (*Scirpus acutus*) that filled them

[12] F. L. Ransome, *The Great Val* University of California, Bulletin of t Geology, Vol. 1, No. 14 (Berkeley: U fornia, 1896), p. 379.

the Sacramento River, and the Colusa and Yolo basins, on the west side.[11]

The relatively high natural levees more or less effectively confined the main streams to their regular channels when water levels were at low or moderate stages. When winter and spring runoffs were high, however, the lower portions of the valley were below the water level of the main streams. Accordingly, in times of high water the lower portions of the flood plain, i. e., the flood basins and parts of the low plains, were converted into huge, shallow, temporary lakes. Because of the flood basins' lowness and shape, such floodwater did not readily escape but persisted for much of the year, causing a luxuriant growth of tules (*Scirpus acutus*) and other marsh plants. Because of large seasonal variation of runoff in the Sacramento River system, the extent of the inundation of flood basins and adjacent areas must have been subject to considerable annual fluctuation.

Before reclamation of the Sacramento Valley, the flood basins and low plains also received flood water from sources other than the main streams. Important among these was the upland runoff that, because of the barrier imposed by the natural levees, could not reach the main streams. In time of high runoff, water poured off the low plains in wide sheets to the low parts of the valley. Because of the lowness of the flood basins and the levee barrier, such upland runoff did not reach the main river but, spreading out from the flood basins, covered large sections of the Sacramento Valley. Since not all tributary streams could link directly with the Sacramento, they drained to the valley floor through a welter of distributaries, losing themselves "in the intricate plexus of sloughs which meander through the tule-land bordering the main river.[12] Few of the east bank tributaries, which are mainly perennial, connected through direct channels with the Sacramento River. The Feather River, for instance, is an example of a Yazoo type stream. In Ransome's words, "only the large tributaries . . . reach . . . the Sacramento by a definite channel, and often that becoming an exceedingly tortuous one."[13] As previously suggested, an additional cause of inundation of low flood plain lands was the overflowing of master streams, and the spilling of water through cracks or "crevasses" in the levees.

Below Clarksburg extends the Sacramento-San Joaquin Delta or, in Bryan's terminology, the islands. This region is cut up into numerous islands because the rivers divide into a complex arrangement of interlaced channels. These islands, of various shapes and sizes, are flat and low-lying with elevations slightly above or below sea level. Before reclamation they were submerged for much of the year, and water levels fluctuating with the tides and the flood stages of the river. The islands' outer margins generally consist of mineral deposits in the form of small natural levees, while the interior sections are composed of organic deposits formed from the tules that formerly covered the area. Most of the delta or island country is now reclaimed for cultivation under a system of artificial levees and drainage and peat is no longer formed. On the contrary, surface levels on the islands have declined since reclamation because of geologic subsidence, compaction by tillage machinery, shrinkage from drying, oxidation, burning, and wind erosion.[14]

Because of the peculiar structure of the Sacramento Valley, coupled with the sinking of the valley relative to sea level, the river system was permitted to build up a much larger area and depth of sediments than its size and age might suggest. Essentially, what happened was that the Sacramento River, below about Red Bluff, was given a very low gradient, and its capacity to carry water and transport its load was thus restricted.[15] But, more or less simultaneously,

[11] In times past, the flood basins were sometimes known as "tules" or "tulares," because of the growth of tule (*Scirpus acutus*) that filled them.

[12] F. L. Ransome, *The Great Valley of California*, University of California, Bulletin of the Department of Geology, Vol. 1, No. 14 (Berkeley: University of California, 1896), p. 379.

[13] *Ibid.*, p. 379.

[14] Walter W. Weir, "Subsidence of Peat Lands of the Sacramento-San Joaquin Delta, California," *Hilgardia*, Vol. 20 (1950), pp. 48–53.

[15] Another major determinant of a stream's discharge capacity, aside from gradient, is the cross-sectional area of the channel. During the Anglo-American period the channel size of much of the Sacramento system has undergone change. Many factors are involved, among them the deposition from hydraulic mining and the effects of flood control measures, changes in vegetation, and changes in erosional rates. However, there is some evidence that even in its pristine condition the channel of the Sacramento was imperfect and conducive to overflows. Thus, in 1880, Hall, the first state engineer, described the Sacramento channel as follows:

> The river has always been one of poor regimen—great vari-

active erosion, promoted by uplift, in the mountainous sections of the river's watershed was supplying the main stream with copious quantities of sediments—which it was ill-equipped to transport. Since the runoff of the river was subject to drastic fluctuations and the river's discharge capacity was very restricted, in times of high runoff it was forced to overflow its banks. Because the river occupied a wide structural trough, the area available to receive overflow water was very considerable. Thus, extensive, nearly level alluvial deposits were built up along both sides of the master streams and the Sacramento River came to be bordered with a disproportionately low, wide, and long aggraded plain. Other depositional features, including natural levees and channel ridges, also developed on a relatively massive scale along the watercourses.

Also conducive to flooding, and in turn to the formation of alluvial land forms and vegetational modification, is the climate of the Sacramento River Basin. For example, while much of the lowland portion of the basin receives an average of less than 20 inches per year and much of the upland receives less than 40 inches, the precipitation is strongly concentrated in a small part of the year and so has a greatly enhanced flood-causing potential. Since the precipitation and warm seasons are out of phase in California, runoff per unit of precipitation is greater than in areas of summer rainfall where evapotranspiration losses are likely to be relatively high. Furthermore, the average annual precipitation misstates the actual precipitation probability, since the average is rarely received. In short, there are drastic departures from yearly precipitation averages, and within single seasons there are tremendous variations in precipitation intensity.

Although the valley floor and lower mountain slopes are characterized by mild winter temperatures, the upland sections of the basin have lower temperatures, often below freezing. Since winter is the season of maximum precipitation and lowest temperatures in the mountain sections of the basin, it follows that much of the upland precipitation is in the form of snow. Such winter snowfall may accumulate to substantial depths. Indeed, few sections of the United States record greater snowpacks than do the western upper Sierra Nevada. In 1880 and 1890, 370 inches of snow fell near Donner Summit,[16] and in 1907 and again in 1911, 308 inches of snow were measured there.[17] Tamarack, Alpine County, in the Sierra Nevada, holds the United States record for the greatest single-season snowfall—884 inches in the winter of 1906–07. Large sections of the Sierra Nevada average over 60 inches of annual precipitation, mainly in snow.

Such massive accumulations of snow melt with the higher temperatures of spring and early summer. Miller calculates the rate of ablation at Summit to be about 0.75 inches of water per day in late April and May, when melting is most rapid.[18] The normally rapid ablation rate for the Sierra snowpack may be even more rapid in individual years, for the melting season varies from year to year. In the last week of May, 1950, when a deep snowpack lasted unusually late, ablation averaged 2.0–2.4 inches of water per day at many stations in the Castle Creek Basin.[19] Although melting of snowpacks at these rates causes substantial, and sustained runoffs, it does not usually cause the rivers to overtop their banks under the modern conditions of flood control. However, it seems clear that snowmelt was a cause of flooding before reclamation and flood control measures were initiated. Therefore, snowmelt floods must have contributed to the alluviation of the valley, including levee formation.

PRISTINE CONDITION OF THE RIPARIAN LANDS

Among the first outsiders to visit the Sacramento Valley were fur trappers of the Hudson's Bay Company in the period prior to 1814. The

ation of capacity to pass the waves of flood through its different divisions—and its channel has always had serious local defects which have acted as obstructions to the passage of ation of capacity to pass the waves of flood through its different flood-waters. Thus, for 106 miles and more above the head of Butte Slough, there is a channel of *greater grade and greater dimensions than there is below*, all the way to the mouth of the Feather River, a distance of 64½ miles. And, again, the very shallow bars known as "Six-mile," "Haycock," "Hog's-back," "Iron House," and "Newtown" shoals, do not permit the free passage of the flood waves, as do the deeper and better formed reaches of the channel above and below them.

William H. Hall, *Report of the State Engineer to the Legislature of the State of California—Session of 1880*, Part I (Sacramento: Superintendent of State Printing, 1880), p. 10.

[16] According to marks made at stations on the transcontinental railroad crossing the Sierra Nevada. *Water Resources of California*, Bulletin No. 1, p. 308.

[17] *Ibid.*, p. 308.

[18] David H. Miller, "Snow Cover and Climate in the Sierra Nevada, California," *University of California Publications in Geography*, Vol. 11 (1955), p. 26.

[19] *Ibid.*, p. 27.

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Spaniard Luis Antonio Arguello investigated the valley in 1817 and again in 1821, and Jedediah Smith, in 1825, may have been the first American to reach the Sacramento River. However, it was not until the 1840's that significant outside influence was felt in the northern end of the Central Valley.

This seclusion, however, could not survive the meteoric developments of the Americanization of California.[20] After 1849 came a huge influx of population, lured by gold but often quickly to adopt other pursuits. These immigrants, mostly with rural backgrounds, could not overlook the agricultural promise of the Sacramento Valley. Heightening the attractions of the Sacramento Valley for agricultural settlement was its virtually vacant condition. Its relatively sparse and unwarlike aboriginal population, having been greatly reduced in numbers by an epidemic in the early 1830's, was unable to offer more than token resistance to the American invaders.[21]

After recognizing the promise of the Sacramento Valley, the invading Americans quickly set about its realization. To do this called for new patterns of occupance and land use; and in the initiation of these the environment was substantially modified. The agencies of change were sufficiently drastic to transform the physical, biotic, and cultural landscape. One of the very first transformations concerned the natural levees and riparian lands, which were thickly forested in their pristine condition.

Because of the brief period between initial investigation and development, little information was accumulated on the aboriginal condition of the Sacramento Valley. One of the earliest observers to report on the riparian forests was John Work, in the course of a fur-trapping expedition from his headquarters at Fort Vancouver. Writing in 1832, he described the riparian forests of the Sacramento Valley, below Red Bluff as follows:

> All the way along the river here there is a belt of woods principally oak which is surrounded by a plain with tufts of wood here & there which extend to the foot of the mountain, where the hills are again wooded.[22]

Speaking of the Sacramento River levees, along the great bend just above the mouth of the Feather River, he had this to say:

> The distance we made down the river was about 10 miles . . . a part of the way through thick woods which during the high water in the winter were overflowed.[23]

He described the riparian forests on the lower Butte Creek:

> Where we are encamped in near the mountain, the bank of the river is well wooded with oak and other trees, and though the ground is very soft it does not appear liable to be overflowed.[24]

On the way up the Feather River to near Oroville the banks were similarly described:

> . . . from the appearance of drift wood the country is liable to be overflowed during high water, though it is pretty thickly wooded with oak timber.[25]

Another early visitor to the Sacramento Valley, Captain Sir Edward Belcher, R. N., noted the profusion of oak, ash, plane, laurel, sumach (*sic*),[26] hiccory (*sic*),[27] walnut,[28] roses, wild grapes, arbutus, and other small shrubs in the vicinity of the river.[29] He described its lower course as follows:

> Having entered the Sacramento, we soon found that it increased in width as we advanced, and at our noon station of the second day was about one-third of a mile wide. The marshy land now gave way to firm ground, preserving its level in a most remarkable manner, succeeded by banks well wooded with oak, planes, ash, willow, chesnut [*sic*],[30] walnut, pop-

[20] Illustrative of the pace of these developments is the well-known fact that California legally passed from the Mexican rule to statehood in the Union in a brief period of two years, skipping the territorial stage.

[21] Cook estimates that a mortality of 75 percent occurred among the Central Valley Indians during the malaria epidemic of 1830–33. See S. F. Cook, "The Epidemic of 1830–1833 in California and Oregon," *University of California Publications in American Archaeology and Ethnology*, Vol. 43, No. 3 (1955).

[22] Alice B. Maloney (ed.), *Fur Brigade to the Bonaventura, John Work's California Expedition 1832–33 for the Hudson's Bay Company* (San Francisco: California Historical Society, 1945), p. 18.

[23] *Ibid.*, p. 57.

[24] *Ibid.*, p. 33.

[25] *Ibid.*, p. 32.

[26] Perhaps Belcher meant poison oak (*Rhus diversiloba*). Could he possibly have been referring to Tree of Heaven (*Ailanthus altissima*)? This is usually considered an introduction of the Gold Rush Chinese.

[27] Perhaps buckeye (*Aesculus californica*); hickory does not occur in California.

[28] Presumably California walnut (*Juglans californica*).

[29] Captain Sir Edward Belcher, R.N., *Narrative of a Voyage Round the World Performed in Her Majesty's Ship Sulphur During the Years 1836–1842*. Vol. 1 (London: Henry Colburn, 1843), p. 130.

[30] Again, probably buckeye.

lar, and brushwood. Wild grapes in great abundance overhung the lower trees, clustering to the river, at times completely overpowering the trees on which they climbed, and producing beautiful varieties of tint. . . . Our course lay between banks. . . . These were, for the most part, belted with willow, ash, oak, or plane [*Platanus occidentalis*],[31] which latter, of immense size, overhung the stream, without apparently a sufficient hold in the soil to support them, so much had the force of the stream denuded their roots.

Within, and at the very verge of the banks, oaks of immense size were plentiful. These appeared to form a band on each side, about three hundred yards in depth, and within (on the immense park-like extent, which we generally explored when landing for positions) they were seen to be disposed in clumps, which served to relieve the eye, wandering over what might otherwise be described as one level plain or sea of grass. Several of these oaks were examined, and some of the small felled. The two most remarkable measured respectively twenty-seven feet and nineteen feet in circumference, at three feet above ground. The latter rose perpendicularly at a [computed] height of sixty feet before expanding its branches, and was truly a noble sight.[32]

The botanist William Dunlop Brackenridge, who traveled the length of the Sacramento Valley in 1841, commented on the presence of "a fine species of Platanus of very graceful groth [*sic*]" on the upper Sacramento banks.[33] Brackenridge had the following to say of the upper Sacramento Valley (probably somewhere east of Willows), presumably referring to parts of the levees and the prairies:

. . . most of the good land was covered with stately Oaks of two different species.[34] I calculated 20 good trees to the acre.[35]

After describing a similar situation near the Feather River, and referring specifically to a levee situation, actually on the lower Feather River, he wrote:

. . . could find no good fording place [i.e., across the Feather River] & therefore kept down along its margin, near this river I saw some of the finest Oak timber observed during the whole trip through from the Columbia. . . .[36]

The pioneer Colusa County settler Justus H. Rogers, describing this area as it appeared in 1843, wrote that lower Antelope Creek

. . . presented to our view not only its well-timbered borders but expanses of fertile and grassy plains, over which roamed innumerable herds of antelope, and hence it was named for the magnificent wild creature.[37]

In 1841 Lieutenant Charles Wilkes described the Sacramento River levee forests upstream from the Sutter Buttes as follows:

The river was here only two hundred feet wide, and its banks but fifteen feet high. The trees on the shores had now become quite thick, and grew with great luxuriance; so much so, that were the sight confined to the river banks, it might be supposed that the country was one continued forest, instead of an open prairie.[38]

Sutter's colleague Heinrich Leinhard, in describing his trip of 1846 up the Sacramento River, made frequent passing references to the thickness and luxuriance of the riparian forests.[39]

In 1842 Theodore Cordua, founder of New Mecklenberg (later Marysville) described this site as follows:

The whole estate was a valley with hardly any trees. There were only a few beautiful oaks. The banks of the river were lined with oaks, alders, willows, and sycamores; here and there were arbors of wild grapes.[40]

Walter Colton, who was in California in 1846–48, commented thus on the city of Sacramento, on the banks of the river:

It is a town in the woods, with the native trees still waving over its roofs. The sails of the shipping are inwoven with the mass awnings.[41]

Edwin Bryant, repo
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the Sacramento Valley

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Referring to the lower
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the levee thus:

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[31] *Platanus racemosa.*

[32] Belcher, *op. cit.*, pp. 120–123.

[33] William Dunlop Brackenridge, "Journal of William Dunlop Brackenridge, October 1–28, 1841," *California Historical Society Quarterly*, Vol. 24 (1945), p. 329.

[34] Valley oak, *Quercus lobata*; interior live oak, *Quercus wizlizenii*; according to Alice Eastwood, "An account and list of the plants in the Brackenridge Journal," *California Historical Society Quarterly*, Vol 24 (1945), p. 341.

[35] Brackenridge, *op. cit.*, p. 329.

[36] Brackenridge, *op. cit.*, p. 330.

[37] Justus H. Rogers, *Colusa County, Its History Traced from a State of Nature through the Early Period of Settlement and Development* (Orland, California, 1891), p. 46.

[38] Lieutenant Charles Wilkes, U.S.N., *Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842*, Vol. V. (Philadelphia: Lea and Blanchard, 1845), p. 187.

[39] Marguerite Eye Wilbur (trans.), *A Pioneer at Sutter's Fort, 1846–1850, The Adventures of Heinrich Leinhard* (Los Angeles: The Calafia Society, 1941).

[40] Erwin G. Gudde (trans.), "The Memoirs of Theodore Cordua, the Pioneer of New Mecklenberg in the Sacramento Valley," *California Historical Society Quarterly*, Vol. 12 (1933), p. 284.

[41] Reverend Walter Colt
Diary (Oakland, California
[42] Edwin Bryant, *What I*
Journal of a tour by the en
of the Rocky Mountains, a
America, the Great Desert
the years 1846, 1847 (Santa
[reprint of 1848 edition]).

[43] *Ibid.*, p. 248.

[44] Francis P. Farquhar
Reports of Lieutenant Ge
Historical Society Quarterly

[45] *Quercus lobata.*

[46] Farquhar, *op. cit.*, p. 1

inwoven with the masses of shade, which serve as awnings.[41]

Edwin Bryant, reporting on a tour of California in 1846–47, described a panoramic view of the Sacramento Valley thus:

> . . . the spacious valley of the Sacramento suddenly burst upon my view, at an apparent distance of fifteen miles. A broad line of timber running through the centre of the valley indicated the course of the main river, and small and fainter lines on either side of this, winding through the broad and flat plain, marked the channels of its tributaries.[42]

And further:

> It (i.e., the Sacramento River) is fringed with timber, chiefly oak and sycamore. Grape-vines and a variety of shrubbery ornament its banks, and give a most charming effect when sailing on its placid and limpid current.[43]

The investigations of Lieutenant George H. Derby, conducted in 1849, shed much light on the pristine condition of the Sacramento Valley, and particularly on the original riparian forests:

> Near its mouth [i.e., the Yuba River's] it widens to about 600 feet, the ground in the vicinity being marshy and covered with tule, and the banks difficult of access on account of the density of the alders and grape-vines with which they are lined. There are many clusters of beautiful trees—oaks, sycamores, and ash—upon its banks, but it is not thickly wooded, as is the case with the Sacramento and Feather rivers and their branches.[44]

Referring to the lower Feather River, near its junction with the Sacramento, Derby wrote of the levee thus:

> Passing the farm-house [i.e., John Augustus Sutter's Hock Farm] to the left, we now entered upon a fine, level prairie, the soil of which was of the richest description, and its surface dotted with the "long-acorn oak"[45] for a distance of two or three miles from the river.[46]

And again:

> The river [i.e., the Feather River] . . . is lined on either bank with majestic sycamores, in a fine grove of which, upon the west bank, is situated Captain Sutter's farmhouse [i.e., Hock Farm], a remarkable neat adobe building. . . .[47]

With reference to the same river, he noted that

> Its banks are thickly wooded, for some two miles in depth, throughout its entire extent, with the holly and long-acorn oaks, sycamores, beech, ash, and alder trees.[48, 49]

And:

> Its banks are heavily timbered, and some fifty feet in height, coming down abruptly to the water.[50]

The banks of Bear Creek were described as "thickly wooded toward its mouth, mostly with scrub-oak, buck-eye, and alder."[51]

Derby's report is especially valuable because it includes a map, "The Sacramento Valley from the American River to Butte Creek, September and October, 1849."[52] This shows the valley as largely treeless or at least with too few trees to justify indicating them symbolically. Large expanses of the lower valley are indicated thus: "Plains from 20 to 30 miles wide with but little vegetation or water terminated to the west by Coast Range of Mountains" (referring to the west side of the valley north of Cache Creek); "Rich Arable Soil" (the Sutter Basin); "Plains usually overflowed in Winter, fine Grazing" (the American Basin); "Plains overflowed in Winter" (the Yolo Basin). Forests are, however, shown by symbol in the form of continuous and extensive strips bordering all of the major and minor streams of the lower Sacramento River system (Fig. 3).

As the final, and most recent, major historical source of information concerning the riparian forests, we turn to the careful and professional reports of the railroad route explorations from the Sacramento Valley to the Columbia River, issued in 1855. Referring to the Sacramento Valley, the reports state that

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[41] Reverend Walter Colton, U.S.N., *The California Diary* (Oakland, California: Biobooks, 1948), p. 232.

[42] Edwin Bryant, *What I Saw in California, being the Journal of a tour by the emigrant route and south pass of the Rocky Mountains, across the continent of North America, the Great Desert basin, through California, in the years 1846, 1847* (Santa Ana: Fine Arts Press, 1936 [reprint of 1848 edition]).

[43] *Ibid.*, p. 248.

[44] Francis P. Farquhar (ed.), "The Topographical Reports of Lieutenant George H. Derby," *California Historical Society Quarterly*, Vol 11 (1932), p. 115.

[45] *Quercus lobata.*

[46] Farquhar, *op. cit.*, p. 113.

[47] *Ibid.*, pp. 112–113.

[48] Holly oak presumably means interior live oak (*Quercus wislizenii*); since no beech is found in the Sacramento Valley, Derby may have meant cottonwood (*Populus fremontii*).

[49] Farquhar, *op. cit.*, p. 116.

[50] *Ibid.*, p. 117.

[51] *Loc. cit.*

[52] *Ibid.*, facing p. 99.

> The more fertile surface is covered with a growth of wild oat, or grasses, interspersed with a great variety of flowering annuals, while the gravelly and more unproductive portions support a thinner growth of coarser plants, [*Eryngium, Hemizonia, Madaria*, &c.]. Of trees, there are none, except such as grow in narrow lines along the streams. These belts of timber are of varying breadth, from a mile or more, or wide-spreading magnificent oaks [generally *Quercus Hindsii*[53]] to a meager border of willows, poplar, or sycamore, hung with festoons of grape along the water's edge.[54]

> A luxuriant growth of wild oats covers a large portion of the valley [i.e., the Sacramento Valley], and gives it an appearance of high cultivation. Grapes, which are a natural product, are also one of the very important staples of the region. The forest trees, which, in the valley, are confined to the banks of streams, are chiefly oaks, sycamores, and cotton-woods [*sic*].[55]

> The valley [i.e., the Sacramento Valley] is destitute of trees, except upon the river banks, and is covered with a luxuriant growth of wild oats.[56]

> It [i.e., the Sacramento River] is bordered by a dense growth of willows, sycamores and oaks.[57]

Referring to the summer desiccation of the Sacramento Valley, the reports indicate that

> Vegetation, except on the banks of the streams, is in a great measure destroyed, and the foliage of the trees furnishes almost the only green upon which the eye of the traveller can rest, when wearied with the glare of the sun, reflected back from the whitened plains.[58]

> The banks of the streams are lined with belts, of greater or less width, of timber, which are composed chiefly of the long-acorned oak [*Q. Hindsii*], here exhibiting a size and beauty of form not surpassed, if equalled, by the oaks of any other part of the world. Along the water's edge, the sycamore [*P. Racemosa, Fraxinus Oregona*],[59] the cotton-wood [*P. Monilifera*][60] and two species of salix [*S. Hindsiana* and *S. lasiandra*?] are overgrown by grape vines [*Vitis Californica*] and form a screen, by which the view of the river is frequently shut out from the traveller upon its banks. At the north end of the valley, along the river, and on the hills which border it, are found many plants not met with below. Of the trees, *Q. Hindsii, Q. Garryana*, and *Q. Agrifolia*,[61] the "nut pine,"[62] and cotton-wood, were the most common.[63]

Referring to *Quercus lobata*, the Railroad Route Exploration Reports comment as follows:

> Along the streams it forms belts of timber of varying width and density, the number and size of the trees being apparently proportioned to the size of the stream and the quantity of moisture derived from it . . . The trunk is often six, seven, or even eight feet in diameter, and covered with a thick and deeply cracked but light colored bark. At the height of ten or twelve feet from the ground the trunk divides into many branches, which throw out their huge arms nearly horizontally to the distance of fifty or sixty feet on either side, the extreme branches in some cases coming quite down to the ground. Near Marysville I measured one—by no means the largest one seen—of which the trunk, three feet from the ground, was six feet in diameter; the height is estimated at seventy-five feet; the circle shaded by its branches measured one hundred and twenty-five feet in diameter.[64]

That these valley oak forests varied considerably in density is suggested by the following:

> On the banks of the Sacramento, in a few instances, I saw this oak when considerably crowded . . . but, generally, both on the hills and on the plain, it inclines to form groups, or open groves in which the trees assume the spreading form . . . .[65]

And in reference to the belt of timber bordering Cache Creek the reports state:

> This timber belt is composed of the most magnificent oaks I have ever seen. They are not crowded as in our forests, but grow scattered about in groups or singly, with open grass-covered glades between them; the trunks, often seven feet in diameter, soon divide into branches, which spread over an area of which the diameter is considerably greater than the height of the tree. There is no under growth beneath them, and as far as the eye can reach, when standing among them, an unending series of great trunks is seen rising from the lawn-like surface.[66]

The forest of the tributary streams is described in these excerpts:

> We then entered a fine oak forest, which skirted the banks of Cache creek. . . .[67]

[53] Valley oak (*Quercus lobata*).
[54] *Reports of Explorations and Survey, to Ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War, in 1854–5, according to acts of Congress of March 3, 1853, May 31, 1854, and August 5, 1854*, United States Senate, 33d Congress, 2d Session, Ex. Doc. 78, Vol. VI, *Geological Report* (Washington, D.C., 1857), pp. 20–21.
[55] *Ibid., General Report*, p. 26.
[56] *Ibid., General Report*, p. 38.
[57] *Ibid., General Report*, p. 57.
[58] *Ibid., General Report*, p. 26.
[59] Oregon ash (*Fraxinus latifolia*).
[60] *Populus fremontii*.
[61] Probably *Quercus wislizenii*.
[62] Digger pine (*Pinus sabiniana*).
[63] *Reports of Explorations and Surveys, op. cit., Botanical Report*, pp. 14–15.
[64] *Ibid., Botanical Report*, p. 30.
[65] *Ibid., Botanical Report*, p. 30.
[66] *Ibid., Botanical Report*, p. 30.
[67] *Ibid., General Report*, p. 57.

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[68] *Ibid., General Report*, p. 57.
[69] *Ibid., Botanical Report*, p. 34
[70] *Ibid., Botanical Report*, p. 3
[71] Francis P. Farquhar (ed.), *fornia in 1860–64, The Journal o* (Berkeley: University of Californi
[72] Belcher, *op. cit.*, p. 123.
[73] Maloney, *op. cit.*, p. 61.

> We followed up Feather river for about 8.5 miles, and encamped near Nicholas. The road to-day was level, and often led through noble forests of oak. There was little or no underbush, and the country resembled a grand old park in appearance .... For a few miles this morning, the road continued to be bordered by the noble oak forest. The extreme shortness of their trunks gave the trees the strange appearance of having been pressed down into the ground. On leaving the forest, we travelled over a dry, dusty plain, which continued to Marysville.[68]

> ... it [i.e., *Platanus racemosa*] is growing on the banks of Feather river, a few miles above its mouth, and situated on the alluvial bottom but some 40 feet above the stream, and a little separated from the belt of timber—principally sycamore—which line its banks. This tree had a diameter of trunk of over 6 feet, an altitude of about 100 feet, and a spread of branches nearly equal to its height, constituting one of the noblest specimens of vegetation I have ever seen.[69]

Platanus racemosa was also noted along the main river:

> We found it bordering the Sacramento river and its tributaries in all parts of the Sacramento valley, but did not meet it further north.[70]

William H. Brewer, in the early 1860's, noted riparian forest species as follows:

> A wide plain borders the river [i.e., Sacramento River] on each side. We caught distant views of the mountains, but generally we saw only the river and its banks, which were more or less covered with trees —willows, cottonwoods, oaks, and sycamores—with wild grapevines trailing from them.[71]

Most of the historical reports give no indication of the actual depth of the woodland. Where Belcher examined the lower Sacramento banks, probably the delta section, in 1837 he noted a belt of large oaks (including one with a trunk 27 feet in circumference at 3 feet above the ground) "about three hundred yards in depth.[72] John Work, in 1832, probably referring to French Camp Creek, a Sierra stream that flows to the delta, wrote: "the plain is overflowed and we had to encamp at the skirt of the woods about two miles from the river."[73] Derby's report of 1849 noted a two-mile-wide belt of woods on both sides of the lower Feather River.[74] The map accompanying this report shows forest bordering all the major and minor streams in the lower Sacramento River system (Fig. 3). Thus riparian forest seems to have bordered the entire mapped portion of the river system from the vicinity of Clarksburg in the south to Glenn in the north. These riparian forests are shown as being fairly uniform in width, about four to five miles. Derby's map also shows riparian forests along the tributary streams almost equal in width to those of the main stream, and flanking the tributaries to the edge of the valley. On the Derby map Cache and Putah creeks have forests about three miles wide, the American and Feather rivers about four miles wide (which checks with a section of his report), and Butte Creek and Yuba and Bear rivers each have levee forests about two miles wide. A note of caution should be inserted here. Derby, although a topographical engineer, performed only a reconnaissance type of survey of the valley. This being so, together with the undoubted fact that the tree symbols are intended to be approximate rather than precise, his map should not be invested with undeserved (and unintended) accuracy. However, even with these limitations the Derby map does suggest riparian forest of substantial width and continuity, and in 1849 these were, of course, still virtually in their pristine condition.

It is highly improbable that the forest belt was of uniform width along both banks of the streams. Indeed, historical accounts clearly indicate the irregular occurrence of the trees. Belcher (1837) refers to the trees as being "disposed in clumps."[75] Derby also speaks of "clusters of beautiful trees—oaks, sycamore and ash" on the banks of the Yuba River to differentiate the forests there from those of the Sacramento and Feather rivers, which were "thickly wooded."[76] Elsewhere he speaks of riparian forests along the Feather River "dotted" for two or three miles back from the river.[77]

The Railroad Reports of a few years later (1855) speak of the riparian forest as being of "varying breadth, from a mile or more ... to a

[68] *Ibid.*, *General Report*, p. 57.
[69] *Ibid.*, *Botanical Report*, p. 34.
[70] *Ibid.*, *Botanical Report*, p. 34.
[71] Francis P. Farquhar (ed.), *Up and Down California in 1860–64, The Journal of William H. Brewer* (Berkeley: University of California Press, 1940), p. 296.
[72] Belcher, *op. cit.*, p. 123.
[73] Maloney, *op. cit.*, p. 61.
[74] Farquhar, *Derby Report*, *op. cit.*, p. 116.
[75] Belcher, *op. cit.*, p. 123.
[76] Farquhar, *Derby Report*, p. 115.
[77] *Ibid.*, p. 113.

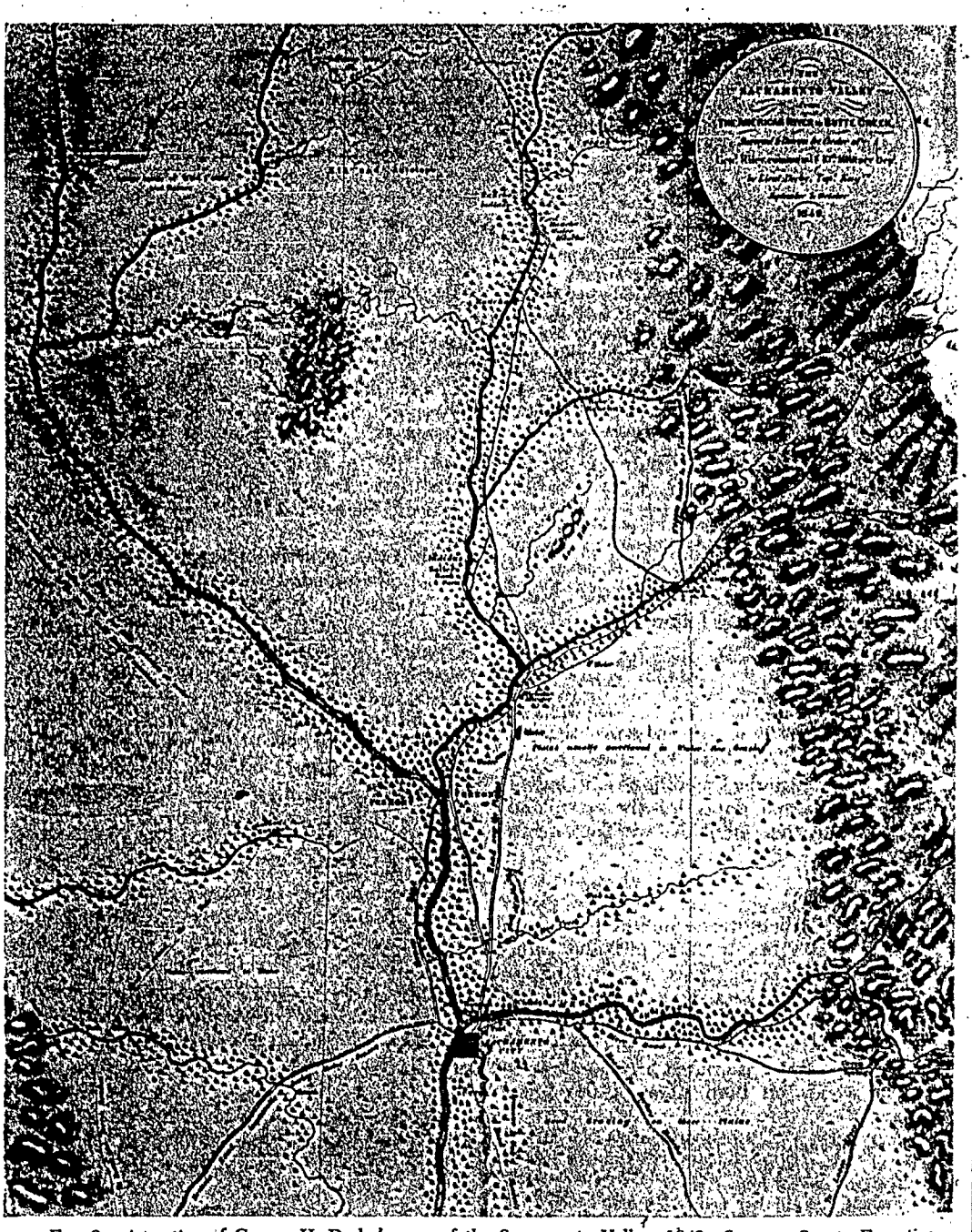

FIG. 3. A portion of George H. Derby's map of the Sacramento Valley, 1849. Source: Senate Executive Document No. 47, 31st Congress, 1st Session, 1850 (Report of the Secretary of War).

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[78] *Reports of Explorations an*
Report, p. 21.
[79] *Ibid.*, *Botanical Report*, p. 1
[80] *Ibid.*, *Botanical Report*, p. 3
[81] Charles Nordhoff, *Northern*
and the Sandwich Islands (Ne
Brothers, 1877), p. 187.
[82] *Map of Butte County, Calif*
Wm. B. Cooke and Co., 1862).

Senate Executive

meager border."[78] Even more generally, but clearly indicating the variation of width in the riparian forests, the Railroad Reports refer to the riparian forests as "of greater or less width."[79] Moreover, the riparian forests varied not only in width but also in tree size and density, "the number and size of trees being apparently proportioned to the size of the stream and the quantity of moisture derived from it."[80]

Charles Nordhoff described the Pratt land grant in Butte County as follows:

> The next grant on the north is that of Judge O. C. Pratt. It contains twenty eight thousand acres of bottom-land. Butte Creek skirts it on one side for a distance of seventeen miles, and a branch of that creek runs through the centre. Nearly six thousand acres are covered with large oak-trees.[81]

Checking the above against a contemporary map[82] reveals that the Pratt grant was as Nordhoff described it, except that the area was actually 26,761 acres and the frontage on Butte Creek, forming its eastern boundary, was closer to 15 miles. If allowance is made for these smaller dimensions, and also for the fact that part of the "nearly six thousand acres" of "large oak-trees" was along Little Butte Creek (referred to by Nordhoff as the branch of Butte Creek that "runs through the centre" of the grant), then it would appear that the riparian forest was about one-half mile wide on the west bank of Butte Creek—a finding, incidentally, that agrees closely with the Derby map.

The preceding discussion shows that in their pristine condition the streams of the lower Sacramento River system were flanked by forests. The historical evidence suggests that these riparian forests had varied characteristics. They included trees of all sizes, from brush to very large valley oaks or sycamores, 75 to 100 feet high, growing closely spaced or scattered irregularly in groves. On the banks of the lower Sacramento, where the natural levees are widest, the riparian forests achieved their greatest width, four to five miles. On the lesser streams and in the delta, with smaller levees, the forests formed a narrower belt, generally about two miles wide but less in the delta. Dominant species in the riparian forest were valley oak (*Quercus lobata*), interior live oak (*Quercus wislizenii*), California sycamore (*Platanus racemosa*), Oregon ash (*Fraxinus oregana*), cottonwood (*Populus fremontii*), alder (*Alnus rhombifolia*), and several willows, including *Salix gooddingii, S. exigua, S. Hindoiana, S. lasiandra,* and *S. laevigata.*[83]

ECOLOGY OF THE RIPARIAN FORESTS

The prominence and significance of these riparian forests was enhanced by the fact that they were set in the nearly level and treeless plain of the Sacramento Valley. The virtually treeless character is attested by abundant historical evidence. There is no doubt that in recent centuries most of the valley supported grassy or herbaceous vegetation (including possibly nearly 1,000 square miles of tules and other marsh plants).[84] Precisely why the Sacra-

[78] *Reports of Explorations and Surveys, Geological Report,* p. 21.

[79] *Ibid., Botanical Report,* p. 14.

[80] *Ibid., Botanical Report,* p. 30.

[81] Charles Nordhoff, *Northern California, Oregon, and the Sandwich Islands* (New York: Harper and Brothers, 1877), p. 187.

[82] *Map of Butte County, California* (San Francisco: Wm. B. Cooke and Co., 1862).

[83] In his report on "The Riparian Botany of the Lower Sacramento" (*Erythea,* Vol. 1 1893, p. 242), Willis L. Jepson described the vegetation of the lower Sacramento River, mainly the delta, as follows:

> The major part of the growth is made up of various species of willow (*Salix nigra,* Marsh, *S. lasiandra,* Benth., and *S. longifolia,* Muhl.). Fine specimens of the Plane Tree (*Platanus racemosa,* Nutt.) are not uncommon. The Cottonwood (*Populus Fremontii,* Watz.) is frequent; while the Button Bush (*Cephalanthus occidentalis,* L.), the Oregon Ash (*Fraxinus Oregana,* Nutt.), the California Walnut (*Juglans Californica,* Watz.) and the Alder (*Alnus rhombifolia,* Nutt.), though not abundant, are to be met with throughout this entire region. The Wild Grape (*Vitis Californica,* Benth.) was noticed in several places. The undergrowth is largely a tangle of California Wild Rose (*Rosa Californica,* C. & S.) and Blackberry (*Rubus vitifolius,* C. & S.), with various herbaceous and suffrutescent plants. The Box-Elder (*Acer Californicum,* Freene) and Poison Ivy (*Rhus diversiloba,* T. & G.) were noticed near Walnut Grove; as also fine individuals of the Live Oak (*Quercus wislizenii,* DC.) on the highest river banks. The River Dogwood (*Cornus pubescens,* Nutt.) is fairly frequent.

[The valley oak should also be included in this list.]

[84] The extent of marshes is difficult to estimate because of seasonal fluctuations and variations of definition. Hittell estimated the area of tule-land "covered five or six feet deep with water in times of flood" in the Sacramento Valley as 200 square miles, together with another 80 square miles on San Pablo Bay. (John S. Hittell, *The Resources of California* [San Francisco: A. Roman and Company, 1863], p. 12 and p. 157.) More likely correct are Hilgard's estimates of the areas of tule in Sacramento Valley counties which total 840 square miles and include only part of the delta. (E. W. Hilgard, *Report on the Physical and Agricultural Features of the State of California, with a discussion of the present and future of cotton production in the state; also, remarks on cotton culture in New Mexico, Utah, Arizona, and Mexico,* from the United States Census Re-

mento Valley was dominated by grasses is uncertain, as is so often the case with grasslands. It is possible, even probable, that grassland was the original great climax of the entire Central Valley. Clements theorizes that bunch grass formerly dominated the Central Valley until it was destroyed by fire, grazing, cultivation, and the invasion of ruderal grasses.[85] According to his interpretation, "the *Stipa* consociations seem formerly to have dominated the interior valley from Bakersfield to Mount Shasta and from the foothills of the Sierra Nevada and Cascade Mountains, through and over much of the Coast Range."[86] This view is based mainly on the discovery of numerous bunch grass relicts in the Central Valley. In addition to the grassland there were extensive areas of marsh vegetation, and, of course, the riparian forest in both the Sacramento and San Joaquin sections of the Central Valley.

The treeless character of the Sacramento Valley floor before agricultural occupation is explained by Jepson as a reflection of soil characteristics and climate.[87] Some portions of the Sacramento Valley—an area of diverse soil types—are too alkaline or sandy for native trees. In addition there are large tracts of heavy, adhesive, adobe soils that become dry and cracked in their upper layers during the dry season, and are glutinous during the wet season. Seedlings cannot naturally survive the summer desiccation in these adobe soils, although they flourish under man's care.

The extensive areas of clay soils, somewhat less heavy than the adobes, do not become so fissured with shrinkage cracks during the summer, but they possess this tree-deterring characteristic to a considerable extent. Further negative influences on tree growth on the valley floor resulted from the frequent widespread inundations of the flood basins and low plains that formerly occurred.[88] The restriction of tree growth was caused by insufficient aeration in the waterlogged soils rather than by too much water which, in itself, is not injurious. Periodic drought, the browsing of animals, and the desiccating effect of strong, dry topographically controlled north winds also militated against the development of trees. Even so, such circumstances have been judged insufficient to explain completely the dearth of trees over so much of the Sacramento Valley.

A probably important supplemental factor in minimizing tree growth was the widespread Indian practice of burning the luxuriant growth of dried-out grasses and herbaceous vegetation during summer. Numerous early visitors to the Sacramento Valley describe the great extent of these fires.[89] The burning of the valley herbs produced a quick, hot fire capable of killing seedlings but doing little damage to established trees. In this connection it may be noted that the valley oak's distinctive bark, often three or four inches thick protection. Where presen the oaks usually stand in distribution that might we infrequent, localized com and biotic influences that ing seedlings to establish ably, grass fires were one influences limiting the gro

Another authority, Co while much of the Sacram been occupied by climatic possibility that parts of th at the northern end, were by chaparral.[90] This interp by the fact that there are differences between the and the areas dominated Furthermore, Cooper poi chaparral well out in th County between Hershey are judged to be relicts. A the most important chapa *stoma fasciculatum*, cann cept when in mass contr where mature individuals (as in parts of Colusa Coun formerly dominant and chaparral.

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Whatever the cause, the in its pristine condition the vegetation consisted largely baceous plants, and that la less. Jepson, writing in 191 sive reclamation and modi ramento Valley, but after th

ports, Vol. 6 (Washington, D. C.: Superintendent of Census, 1883), pp. 87–92.) Hall's classification of the Sacramento Valley (below) indicates an even greater expanse of marsh although it does not show specifically the area of tule.

CLASSIFICATION OF SACRAMENTO VALLEY LANDS IN 1880

Designation	Area in Square Miles
High hill lands—Marysville Buttes	55.50
Low hill or rolling lands, adjacent to the foothills of the mountains	650.00
Dry plains, above reach of all overflow	2,321.45
Dry plains, subject to occasional temporary overflow from the tributary streams	450.00
Lands covered by debris and subject to flooding, river bottom or marginal lands naturally subject to temporary shallow annual overflow; low basin lands, not tule swamp, naturally subject to deep annual flooding; low basin lands, tule swamps, naturally subject to protracted deep annual flooding; island swamp lands and other tule swamps, naturally subject to flooding by high tides	1,254.00
River, slough, and channel surface of perennial streams	38.05
Total	4,769.00

Source: W. H. Hall, *Report of the Engineer to the Legislature of the State of California—Session of 1880, Part II, Drainage of the Valleys and the Improvement of the Navigation of Rivers* (Sacramento: Superintendent of State Printing, 1880), p. 7.

[85] Frederic E. Clements, *Plant Indicators, The Relation of Plant Communities to Process and Practice* (Washington, D. C.: Carnegie Institution, 1920), p. 150, and *Dynamics of Vegetation* (New York: H. W. Wilson, 1949), p. 184.

[86] *Plant Indicators*, p. 150.

[87] Willis L. Jepson, *The Silva of California*, Memoirs of the University of California, Vol. 2 (Berkeley: The University Press, 1910), pp. 10–11.

[88] For further discussion of flooding in the Sacramento Valley see Kenneth Thompson, "Historic Flooding in the Sacramento Valley, California," *Pacific Historical Review*, Vol. 29 (1960), pp. 349–360.

[89] John Work, for example, noted in 1833 that near the junction of the Feather and Sacramento rivers "The country has recently been overrun by fire so that we can scarcely find feeding for our horses." Maloney, *op. cit.*, p. 70.

[90] William S. Cooper, *The Bro tion of California* (Washington, tution, 1922), pp. 76–81.

[91] R. Merton Love and Burle J. *ifornia Brush Ranges*, Californi ment Station Circular 371 (B California, 1947), pp. 10–13.

three or four inches thick, provides good fire-protection. Where present on the valley floor, the oaks usually stand in scattered groves—a distribution that might well be explained by an infrequent, localized combination of edaphic and biotic influences that permitted germinating seedlings to establish themselves. Presumably, grass fires were one of the major negative influences limiting the growth of seedlings.

Another authority, Cooper, suggests that while much of the Sacramento Valley may have been occupied by climatic grassland there is a possibility that parts of the valley, particularly at the northern end, were formerly controlled by chaparral.[90] This interpretation is supported by the fact that there are no marked climatic differences between the Sacramento Valley and the areas dominated today by chaparral. Furthermore, Cooper points to small areas of chaparral well out in the valley, in Colusa County between Hershey and Arbuckle, which are judged to be relicts. According to Cooper, the most important chaparral species, *Adenostoma fasciculatum*, cannot establish itself except when in mass control. He argues that where mature individuals of *Adenostoma* occur (as in parts of Colusa County), that species was formerly dominant and the area supported chaparral.

Cooper explains the elimination of the chaparral from the Sacramento Valley and elsewhere in California mainly through burning, possibly coupled with local clearing for cultivation and fuel. While admitting that fire favors the extension of chaparral at the expense of forest, he argues that *repeated* burning (such as occurred in the valley) favors grassland at the expense of chaparral. Recent work on range improvement supports this claim.[91]

Whatever the cause, there is no doubt that in its pristine condition the Sacramento Valley vegetation consisted largely of grasses and herbaceous plants, and that large areas were treeless. Jepson, writing in 1910, before the extensive reclamation and modification of the Sacramento Valley, but after the destruction of the riparian forests, described the Central Valley as follows:

> Extensive treeless areas are the most characteristic features of the Sacramento and San Joaquin valleys. The wooded areas are thin and limited in extent. The east side of the Sacramento and San Joaquin Valleys supports the greater part of the groves of scattered trees as contrasted with the west side which is in the main treeless.[92]

Jepson went on to note that the remaining woodland was largely restricted to the natural levees:

> Wherever trees are found on the plains proper, east side or west side, they are generally associated with the alluvial loams. This fact is related to the presence or absence of living streams and the mountain ranges in which the streams originate. On the east side of the "Great Valley" large rivers, emerging from the Sierra Nevada and flowing across the plains to the main arteries in the center of the valley, have built up alluvial deltas or have covered the plains with strata of the finest loam. The broad alluvial banks of these streams are often higher than the country lying behind them, particularly toward the foothills, and support open groves of Valley Oak and Interior Live Oak, which in some cases, although rarely, spread as a scattered growth over the inter-riparian plains. The west side of the San Joaquin and Sacramento valleys is similarly traversed by streams emerging from the Coast Ranges. While these are flood rivers in winter, they present dry beds in summer or towards the north only feeble streams. Wherever such streams have built up broad alluvial banks, as along Cache, Putah, Ulatis, and Alamo creeks, they support groves of scattered trees of the characteristic species named above.[93]

And similarly:

> On creek banks or in river bottoms, where on the other hand the soil is wet and the grass green all summer, we usually find dense stands composed of the characteristic Willows, Cottonwoods and other trees. The main rivers, especially, are marked by a dense arboreous fringe consisting of Black Willow, Red Willow, Yellow Willow, Box Elder, Common Cottonwood, Oregon Ash, Interior Live Oak, Valley Oak, and often with extensive areas of marsh lands filled with tule lying back of their alluvial banks.[94]

Jepson then relates the Sacramento Valley woodland to soil type (loams) and favorable ground-water conditions (natural levees or river banks)—a distribution confirmed for an earlier date from historical records and modern relicts. This distribution results from a number of factors. *Quercus lobata* is best developed where soil moisture is abundant, especially

[90] William S. Cooper, *The Broad-Sclerophyll Vegetation of California* (Washington, D. C.: Carnegie Institution, 1922), pp. 76–81.

[91] R. Merton Love and Burle J. Jones, *Improving California Brush Ranges*, California Agricultural Experiment Station Circular 371 (Berkeley: University of California, 1947), pp. 10–13.

[92] Jepson, *Silva*, p. 10.

[93] *Ibid.*, p. 10.

[94] *Ibid.*, pp. 11–12.

where the depth to the permanent water table is not too great. The loam soils of the riparian lands, pervious to rains and subsoil irrigation from the watercourses, provide not only favorable ground-water conditions but also soils of the highest fertility. Hence "it is the valley oak by necessity, as it is the valley oak *par excellence*." Valley oaks have a well-developed main root and numerous and large lateral roots. Both are capable of deep penetration, and the laterals may extend widely, but the greatest root development occurs fairly deep. It is thus well adapted to habitats where the soil moisture supply is abundant at a considerable depth, i.e., natural levee or riparian sites.[95]

Given the "water soaked condition of the soil, the richness of the alluvial land, and the heat of the unclouded summer sun, plant life in this region [i.e., riparian lands] is endowed with all the requisites for the most robust growth."[96] Accordingly, on riparian sites tree growth is relatively rapid and the trees attain very large sizes. Another favorable aspect of the natural levee or riparian site is relative freedom from fire. The numerous grass fires of aboriginal times probably had fairly little effect on the riparian forests. Since the burning was mainly conducted on the desiccated grasslands, toward the margins of the valley, the fires may not actually have reached the riparian forests, for the intervening swamps would have formed an effective firebreak. Furthermore, even where the fires did reach the levees the moist conditions assured a more verdant vegetation which reduced the possibilities of fire. Jepson, writing in 1893, contrasts the desiccated plains with the green river lands.

> The herbaceous plants on the plains are chiefly annual, and the rapidity with which they attain their full size, perfect their seeds, and pass away is the wonder of the botanical traveler. The wide plain is covered with showy Lupines, Clovers, Calandrinias, Platystemons, Baerias, Gilias, Nemophilas and Allocaryas. The shallow streams and pools are edged with handsome Euanani and curious Bolelias.[97] The tide of plant life reaches its maximum from April 5 to 20. In one, two, or three weeks more the brilliant colors have faded from the landscape and the vernal aspect is succeeded by the dullness and aridity of summer. For months there is nothing to be seen but the grass-whitened plain, only later relieved by tufts of Grindelia and broad areas of the exclusive Hemizonias.
>
> As the traveler passes late in the year from the sun-scorched plains to the riparian region, the change in the physiognomy of the country is decided and impressive. Even in September and October the river country is as fresh and green as the landscape in April on the plains of the Sacramento and in the lower foothills of the Sierra. The prevailing freshness of foliage is emphasized by the strength and richness of autumnal inflorescence .... The two regions which are here contrasted lie in closest proximity ....[98]

PRESENT CONDITION OF THE RIPARIAN FORESTS

Although the Sacramento Valley riparian forests were an early casualty of the white man, their destruction, far-reaching as it was, was not complete. Today, parts of both banks of the Sacramento and its tributaries are bordered by many shrunken remnants of the once extensive riparian woodland. The numerous traces that remain corroborate the historical evidence examined by the author. The same tree species mentioned in the historical records—mainly valley oaks, cottonwoods, willows, sycamores, and ash—still grow on the river banks, natural levees, and channel ridges. Typically, cottonwoods and willows predominate on the immediate stream banks, whereas valley oaks are spread irregularly over the natural levees farther away from the river.

Instead of a strip measurable in miles, the forested zones along the Sacramento Valley streams are now often only yards deep, and discontinuous at that. Generally, the remaining fragments (not necessarily virgin stands, of course) form a belt less than 100 yards wide and are largely confined to bank slopes of streams and sloughs, abandoned meanders, and on the river side of artificial levees.

Examination of the Sacramento River levees reveals hundreds of larger relict stands of riparian forest. Some cover only a few acres; others several hundred. Most prominent are fully mature specimens of valley oaks in the "weeping" stage of development described by Jepson as indicating an age between 125 and 300 years.[99] Such trees occur mostly on natural levee or channel ridge sites and are frequently around older settlements, presumably preserved for shade and ornament. Even small house lots

[95] W. A. Cannon, "Specialization in Vegetation and in Environment in California," *The Plant World*, Vol. 17, No. 8 (1914), pp. 234–235.
[96] Jepson, *Erythea*, p. 241.
[97] *Euanani* = *Mimulus*, *Bolelia* = *Downingia*.
[98] Jepson, *Erythea*, pp. 240–241.
[99] Jepson, *Silva*, p. 205.

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[100] Titus Fey Cronise, *Th*
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[101] *Ibid.*, p. 297.

may contain two or more oaks that predate the Anglo-American settlement period, presumably relicts of a more extensive stand. Some tracts of uncleared land near the Sacramento River (including two in Yolo County between Knights Landing and Elkhorn Ferry) are still so thickly studded with trees, including many valley oaks in the "weeping" stage, that they form the definite, if open, forest described by early visitors to the region.

Near Woodson Bridge, Tehama County, another expanse of apparently virgin riparian forest can be seen. It is still subject to almost annual overflow and is composed mainly of mature valley oaks, forming an open woodland that extends discontinuously for about a mile from the river's edge. Some splendid mature specimens of valley oak remaining from the Cache Creek riparian forest can be seen in the older residential sections of Woodland in Yolo County, which is named for the fine oak forest in which the settlement was established in 1855. Again, in and around Davis, also in Yolo County, there are many large relict oaks of the Putah Creek forests.

DISAPPEARANCE OF THE RIPARIAN FORESTS

In an area devoted so intensively to agriculture, it is not hard to explain the destruction of the riparian forests. Given the generally treeless nature of the valley floor the riparian forests were doomed to rapid effacement under Anglo-American occupance. Thus, Cronise, at the early date of 1868, could say of Tehama County that: "... the cottonwood and sycamore formerly growing along the Sacramento and other streams, being now nearly all cut away."[100] Referring to Colusa County, he wrote:

> Many of the water courses were originally skirted by narrow belts of trees, consisting chiefly of sycamore and cottonwood; but these having been mostly cut away the settled parts of the county are but scantily supplied with fuel and fencing timber.[101]

In his account of Yuba County, he noted that:

> The county is watered by the Feather River, separating it from Sutter on the west; by the Main Yuba and its Middle Fork; by Bear River dividing it from Placer and Sutter counties on the south; by Honecut creek, its northwestern boundary, and by Dry creek, running centrally through it from northeast to southwest. Originally the banks of these streams were timbered along their lower portions, after the manner common in this region—a few oaks being scattered over the valley lands and lower foot-hills. But most of this growth has now been removed ...[102]

Solano County was observed by Cronise to be

> ... one of the most sparsely timbered counties in the State; the prairies and hills being barren of trees of any kind whatever, while the growth along the water courses, originally limited in extent, is now nearly all cut away.[103]

In Sacramento County, as elsewhere, he noted the presence of

> ... oak, sycamore and cottonwood, being confined chiefly to the alluvial flats and the banks of the streams. The timber belt along the Sacramento was at one time so broad and dense as to render the navigation of that stream difficult by sail vessels, this craft often being several days making the passage even with a favorable wind from the mouth of the river to the Embarcadero [i. e., Sacramento city].[104]

Cronise's detailed observations attest to the previous existence and large-scale destruction by 1868 of the riparian forests. Several reasons account for the speed of this destruction. Of major importance was the cutting of the riparian trees for various domestic and industrial uses—e.g., as fuel and fence material. At Knights Landing, on the banks of the Sacramento River, in pioneer times huge quantities of cordwood were loaded on passing ships for use as fuel.[105] Since Knights Landing is backed by the treeless Yolo Basin, this wood must have come from the riparian forests of the Sacramento River and Cache Creek. It may be assumed that fueling the many wood-burning steam vessels on the Sacramento River system accounted for much of the early destruction.

In view of the general lack of trees in the Sacramento Valley, the riparian forests must have served as a source of fuel, construction, and other types of wood for a wide area. There was doubtless little incentive to conserve the riparian forests, since few of the tree species have much value as lumber. Typically the riparian forest species are fit only for low economic uses. For example, the numerous members of the genus *Salix* (willow) generally yield soft, light, and brittle wood of poor form for saw timber.

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[100] Titus Fey Cronise, *The Natural Wealth of California* (San Francisco: H. H. Bancroft, 1868), p. 289.
[101] *Ibid.*, p. 297.
[102] *Ibid.*, p. 300.
[103] *Ibid.*, p. 305.
[104] *Ibid.*, p. 309.
[105] Communication from local resident.

Rather similar is the cottonwood, which is soft, brittle, not durable, and especially liable to cracking.[106] The largest, and probably most numerous, riparian tree, the valley oak, is "very brittle, firm, often cross-grained and difficult to split or work. On account of its poor timber form the trees are rarely if ever cut for anything but fuel, for which, however, they are much used."[107] The genus *Platanus* (sycamore) is also of limited economic value.

Although California was, and still is, in the aggregate, richly endowed with timber resources, many areas of relatively dense settlement, particularly agricultural settlement, were poorly supplied with timber. The president of the principal agency then concerned with the promotion of agriculture, the California State Board of Agriculture, summarized the situation in 1868 as follows:

> The agricultural counties, as a general thing, have only narrow strips of timber along the water courses, consisting mostly of scrub oak, cottonwood, sycamore and willow, of but little general value, except for wood [i.e., fuel].[108]

The consequences of this situation were stated by the same person thus:

> The cost of lumber for building and fencing, in most of our agricultural districts, obtained, as it is, at a distance of hundreds of miles away, is even now so great that our farmers are among the poorest housed people of any agricultural community in the Union, where the country has been settled an equal length of time. Their crops and stock are but poorly sheltered, if at all, and their farms are worse than poorly fenced.[109]

Scarcity of timber in the agricultural sections of the state, mainly the Central Valley, was a matter of concern to the California State Agricultural Society, and as early as 1868 the society's president was urging that "premiums and bounties" should be offered for the planting of shade and forest trees.[110] By the winter of 1870 a premium of fifty dollars was awarded "for the largest quantity of useful forest trees planted during the year." There were three applicants for the award, one from Alameda County and two from Sacramento County.[111] The supporting statement of one of the unsuccessful applicants for the award casts light on the riparian forests and their destruction:

> The rapid disappearance of the forest trees all over our State, especially in localities bordering upon our rivers and sloughs, has for several years excited the attention of all who claim a home in California and feel an interest in the future welfare of our State.
>
> Since the writer became a resident of this county [i.e., Sacramento County], there was a fine growth of oak and sycamore timber bordering the Sacramento from the city to its mouth, which, it would be safe to say, would yield from one thousand-two hundred to two thousand cords of wood for every half mile, on either side. The oak trees were generally straight and handsome; many of them would make two rail cuts of twelve feet each in length, with several cords of wood left in the top. This fine growth of timber which once graced our river, tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared—the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood. One of the greatest disadvantages which the farmers of our plain lands labor under is the want of timber lands and forest trees. There is nothing to protect the growing grain, the young vineyards, or the newly planted orchard from the fierce northerly winds which visit us almost periodically, and generally come at the most critical time for the farmer, and in two days time blow his hope of a good harvest for the season into despair.[112]

In a similar vein was Nordhoff's suggestion, referring to the lack of trees in the Central Valley, that farmers should plant "live" fences of willow, sycamore, and cottonwood (typical riparian forest species) in December; and, as he optimistically put it, "these would strike root at once, and grow so rapidly that in the second year the farmer cuts his fire-wood from these living fences."[113] Another expression of the timber shortage in the Sacramento Valley was the eucalyptus-planting mania of the late nineteenth century.[114] In an area resorting to such

[106] George B. Sudworth, *Forest Trees of the Pacific Slope* (Washington, D. C.: Department of Agriculture, 1908), pp. 212, 251.

[107] *Ibid.*, p. 278.

[108] Report to His Excellency, H. H. Haight, Governor of California, by C. F. Reed, President of the State Board of Agriculture, *Transactions of the California State Agricultural Society during the years 1868 and 1869* (Sacramento: State Printer, 1870), p. 29.

[109] *Ibid.*, p. 31.

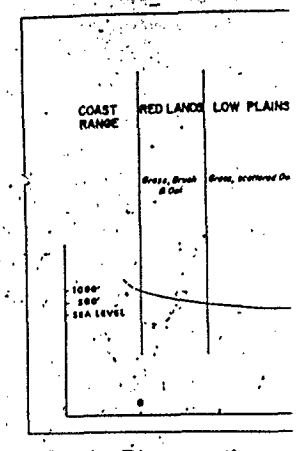
[110] *Ibid.*, p. 33.

[111] "Winter Premiums for 1870, Artificial Forest Culture," *Transactions of the California State Agricultural Society during the Years 1870 and 1871* (Sacramento: State Printer, 1872), p. 132.

[112] "Statement of Mr. E. T. Aiken, of Sacramento County," *Ibid.*, pp. 133–134.

[113] Charles Nordhoff, *California for Health, Pleasure, and Residence* (New York: Harper and Brothers, 1882), p. 102.

[114] "Eucalyptus," *Sunset Magazine*, Vol. 117, No. 2 (August, 1956), pp. 44–47.



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[115] Charles Loring Brace, *The nia in 1867–1868* (New York: 1869), p. 357.

[116] B. S. Alexander, G. H. Men *Report of the Board of Commissi*

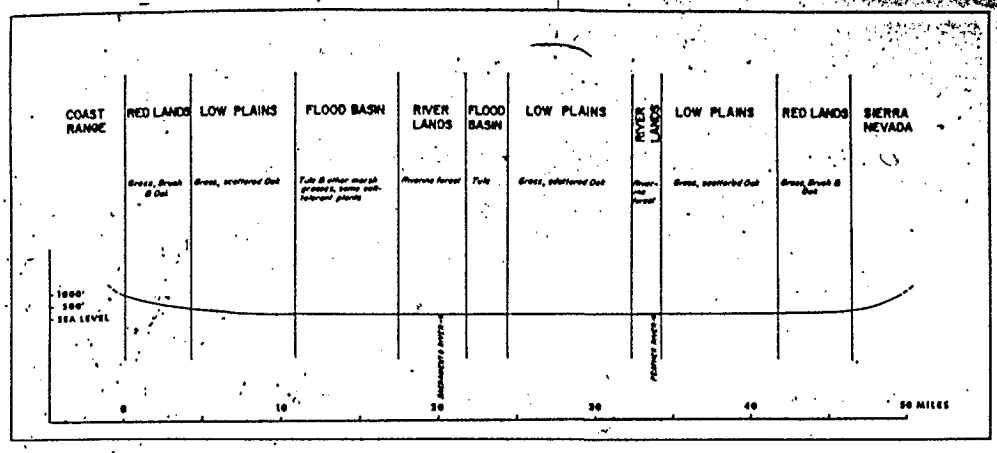

FIG. 4. Diagrammatic cross section of the Sacramento Valley, south of Sutter Buttes, showing the general relationship between physiography and vegetation.

measures to acquire a local timber supply it is hardly surprising that the riparian forests were quickly felled.

The clearing of the riparian forest for fuel and construction also served another end: it made available for agricultural use some of the most fertile and easily managed land in the valley. In its pristine, or nearly pristine, condition much of the valley was more or less unusable for agriculture because of waterlogging and inundations. Cultivation, and even stock-raising, on the valley floor prior to reclamation was notoriously hazardous. One danger was winter or spring flooding; thus Brace, after observing the Sacramento Valley in the late 1860's, recommended agricultural settlement in the Sierra foothills because there "the crops can never be drowned out by winter floods."[115] In addition there was the danger that light winter rains, or excessive summer heat, might cause an insufficient supply of water in the soil for crops. Crop failures for this reason were frequent. A government report issued in 1874, referring to the Central Valley generally, characterized crop failures from inadequate natural water supplies thus:

> . . . the experience of the country . . . is that one crop in three years or two crops in five years is all that can be raised.[116]

However, both these hazards were less severe on the river lands. Because of their higher elevations the levees were largely immune from inundation. Furthermore, they tended to be better drained than much of the other alluvial features because the levees and river lands were composed of coarser-textured soils. In general, these riparian soils were the most fertile and easily managed of the valley, and hence the first to attract agricultural settlement. This fact was recognized from the beginning; Hittell stated that "the richest soil is on the immediate bank."[117] Another early, and more explicit, statement along the same lines indicated that "the richest lands are the bottom lands, which fringe the rivers and larger streams for a distance of one to three miles."[118]

The flood protection offered by the natural levees was summarized by Bryan as follows:

> Although the height of these belts [i. e., the natural levees] above the adjacent country is not great, it is sufficient to make them habitable and arable and thus to separate them rather sharply from the swampy and frequently submerged wastes through which they extend for many miles.[119]

[115] Charles Loring Brace, *The New West or California in 1867–1868* (New York: G. P. Putnam and Son, 1869), p. 357.

[116] B. S. Alexander, G. H. Mendell, and G. Davidson, *Report of the Board of Commissioners on the Irrigation of the San Joaquin, Tulare, and Sacramento Valleys of the State of California*, House of Representatives, 43d Congress, 1st Session, Ex. Doc. No. 290 (Washington, D. C., 1874), p. 13.

[117] Hittell, *op. cit.*, p. 11.

[118] Anon., *A Memorial and Biographical History of Northern California* (Chicago: Lewis Publishing Company, 1891), p. 190.

[119] Bryan, *op. cit.*, p. 10.

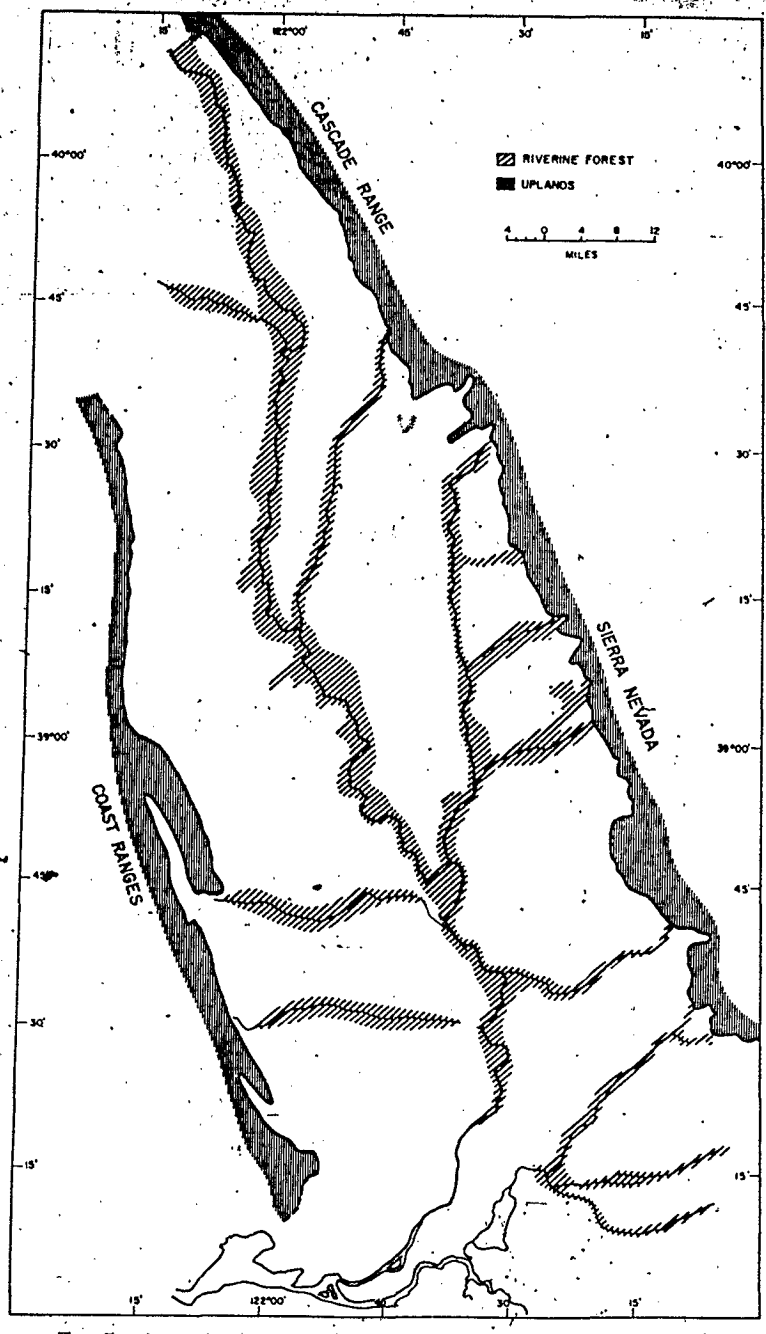

FIG. 5. Approximate extent of riparian forest in the Sacramento Valley.

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The original limitations of many valley areas have been partially overcome in recent decades with improved drainage, irrigation, and other technical advances. However, initially these limitations were such as to discourage permanent settlement and agriculture on much of the valley floor with the exception of the natural levee lands. There both settlement and cultivation were concentrated; utilization of the remainder of the valley was uncertain and irregular, with much attention paid to livestock raising. The general superiority of the levee lands still holds. The most profitable form of land use in the valley, orchards, shows a very marked concentration on levee soils, a final confirmation of their inherent suitability for tree growth.

CONCLUSION

Although edaphic and biotic influences precluded trees from most of the Sacramento Valley in its pristine condition, the riparian lands (mainly natural levees) supported a flourishing tree growth—valley oak, sycamore, cottonwood, willow, and other species. A number of factors contributed to their presence—principally sub-irrigation, fertile alluvial loam soils, and relative freedom from surface waterlogging and fire. These riparian forests varied considerably in width, from a narrow strip to several miles. They also varied greatly in the spacing of the trees, from irregular open to fairly crowded stands, but were generally of sufficient extent and closeness to justify the term "forest" (Figs. 4 and 5).

Perhaps because the riparian forests were largely effaced during the first two or three decades of Anglo-American occupance their existence is largely overlooked by modern students of the Sacramento Valley. But this neglected element in the landscape is by no means of negligible importance. The riparian trees served to reinforce the river banks and provide greater stability to the stream channels. They also acted as windbreaks, reducing evaporation, transpiration, and wind damage. In addition, the riparian forests provided a haven for the wildlife of the valley, furnishing cover and food sources for land and arboreal animals. Even more important was the fact that acorns, mainly from *Quercus lobata*, was a staple foodstuff of the Indian population. Furthermore, the forests furnished an important source of wood in an area otherwise poorly supplied.

The mere existence of the riparian forests, however, inevitably spelled their doom. The conditions, characteristic of natural levee sites, that permitted their development—comparative freedom from flood and waterlogging, high soil fertility, and favorable soil moisture—eventually led to their destruction, for the existence of the forest was incompatible with the modes of land use initiated by the Anglo-Americans. Today, only a few traces of the formerly extensive riparian forests remain, and the Sacramento Valley exhibits a striking lack of trees.